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THIRD UNITED NATIONS CONFERENCE ON THE EXPLORATION AND PEACEFUL USES OF OUTER SPACE

INFORMATION SYSTEMS FOR RESEARCH AND APPLICATIONS (with emphasis on global environmental issues)

Background paper 8

The full list of the background papers:

1. The Earth and its environment in space
2. Disaster prediction, warning and mitigation
3. Management of Earth resources
4. Satellite navigation and location systems
5. Space communications and applications
6. Basic space science and microgravity research and their benefits
7. Commercial aspects of space exploration, including spin-off benefits
8. Information systems for research and applications
9. Small satellite missions
10. Education and training in space science and technology
11. Economic and societal benefits
12. Promotion of international cooperation

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PREFACE

The General Assembly, in its resolution 52/56, agreed that the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) should be convened at the United Nations Office at Vienna from 19 to 30 July 1999 as a special session of the Committee on the Peaceful Uses of Outer Space, open to all Member States of the United Nations.

The primary objectives of UNISPACE III will be:

- (a) To promote effective means of using space technology to assist in the solution of problems of regional or global significance;
- (b) To strengthen the capabilities of Member States, in particular developing countries, to use the applications of space research for economic and cultural development.

Other objectives of UNISPACE III will be as follows:

- (a) To provide developing countries with opportunities to define their needs for space applications for development purposes;

- (b) To consider ways of expediting the use of space applications by Member States to promote sustainable development;
- (c) To address the various issues related to education, training and technical assistance in space science and technology;
- (d) To provide a valuable forum for a critical evaluation of space activities and to increase awareness among the general public regarding the benefits of space technology;
- (e) To strengthen international cooperation in the development and use of space technology and applications.

As one of the preparatory activities for UNISPACE III, the Office for Outer Space Affairs of the Secretariat has prepared a number of background papers to provide Member States participating in the Conference, as well as in the regional preparatory meetings, with information on the latest status and trends in the use of space-related technologies. The papers have been prepared on the basis of input provided by international organizations, space agencies and experts from all over the world. A set of 12 complementary background papers have been published and should be read collectively.

Member States, international organizations and space industries planning to attend UNISPACE III should consider the contents of the present paper, particularly in deciding on the composition of their delegation and in formulating contributions to the work of the Conference.

Sources and information provided by the World Meteorological Organization (WMO), the European Space Agency, the Centre national d'études spatiales (CNES) of France, the National Aeronautics and Space Administration (NASA) of the United States of America and the President of the International Society for Photogrammetry and Remote Sensing and review of the paper by experts from the Economic Commission for Africa, CNES, the Canadian Space Agency, the Indian Space Research Organization and the Department of Space of the Government of India, the National Institute of Aeronautics and Space (LAPAN) of Indonesia and NASA are gratefully acknowledged.

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SUMMARY

Information systems are fundamental tools for dealing with Earth observation data and other inputs, handling and integrating them through appropriate algorithms and generating output in the forms that are most suited to the intended user group. Dedicated numerical models and geographic information systems (GIS) are the most common types of system, the former used largely for the analysis and prediction of weather, climate and ocean currents, and the latter being important for land mapping, cadastral applications or disaster monitoring, in particular at the local and regional levels.

An important asset of the systems is their data-handling capacity. Firstly, they take in data of different origin, content and format. Secondly, they offer to the operator wide flexibility in manipulating the data and displaying them in a user-appropriate form. Finally, they permit the integration of data into a value-added product, the information content of which is higher than that of the individual items of data and is customized to meet user needs. The power of such tools depends not only upon their technical characteristics but also upon the quality of the input data and on keeping the database up to date with new data. Earth observations from space provide a coherent, objective and regular source of input data for such information systems.

Information systems are therefore of value for monitoring purposes, for observing an event and for planning and prevention activities. They are valuable tools for both research work and application activities, and eventually in decision-making.

The present paper reviews information systems and their capabilities to address such critical issues as global change, desertification, biodiversity and deforestation, and the need for a global approach to research that is cognizant of the needs of developing countries. It also covers the types of information needed for applications and the means by which such information could be acquired.

I. GLOBAL ISSUES AND ASSOCIATED INFORMATION SYSTEMS

A. Philosophy

1. For the planet Earth, great strides have been made in identifying and communicating to the general public major global issues such as depletion of the stratospheric ozone, desertification, forest preservation, coastal changes, biological diversity, the El Niño phenomenon, the increasing greenhouse effect and global warming. International concern in that respect is reflected in many international agreements, including, for example, the United Nations Framework Convention on Climate Change, the Rio Declaration on Environment and Development, adopted by the United Nations Conference on Environment and Development, held at Rio de Janeiro from 3 to 14 June 1992, the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa, the Convention on Biodiversity and the Montreal Protocol on Substances that Deplete the Ozone Layer.
2. Those issues have become familiar to the public at large, although people are often unaware or confused about the real impact of such phenomena on mankind and the Earth's environment. The complexity of the interactions among the components of the Earth's system, namely, land, ocean and atmosphere, and their reactions to a change of one (or more) physical or chemical conditions are indeed difficult to analyse. It is therefore often not easy to identify a long-term trend and to separate its natural component from a possible effect induced by human activities.
3. Various international projects, like those associated with the World Climate Research Programme or the International Geosphere-Biosphere Programme, are aimed at gaining a better understanding of those phenomena. The issue of the interactions at different scales, from global to regional to local, is another major subject of research.
4. In that respect, information systems are fundamental tools for ingesting Earth observation data and other inputs on such phenomena, handling and integrating them through appropriate algorithms and generating output products in the forms most suited to the intended user groups.
5. The accuracy of the performance of models and the skill of the people involved in the analysis of their outputs affect the type and quality of decisions that are made about the above issues at the various stages of intervention, namely, before (simulation and prevention), during (monitoring and emergency actions) and after (impact analysis, reduction and mitigation). This is true both with regard to planning activities and to situations involving a disaster or environmental emergency.
6. Currently, two main categories of tools are commonly used for such activities: numerical models and geographic information systems (GIS). The former are used mostly in weather, ocean and climate analyses and forecasts, where observation data are assimilated by the numerical models in the form of digitized geophysical parameter values and integrated into systems of equations describing the static, dynamic, thermodynamic or chemical systems. First the "analysis", or description of the current status, is generated and then the forecast is derived by running the model forward in time through a suitable propagation model.
7. GIS are dedicated systems used primarily to achieve a comprehensive description of the environment and its territorial characteristics, generally on a local or regional scale. Inputs comprise a variety of digitized parameters describing the different aspects of an area: administrative borders, natural features like rivers and lakes, vegetation, topographic features, public transport elements such as roads and railways, pedological information, human settlements, geological patterns and so on. The merging of those elements together with the use of colours provide composite results, generally in the form of maps, which are the most readily understood means of visualizing the information related to the territory.

8. An important asset of information systems is their data-handling capacity. Firstly, they accept data of different origin, content and format. Secondly, they offer the operator great flexibility in manipulating the data, merging them and displaying them in a user-appropriate form. Finally, they permit the integration of data into a value-added product, whose information content is much greater than that of the source data and which can be customized to meet the user's requirements. The power of such tools depends not only on their technical characteristics but also on the quality of input data, in particular on the "age" of such data. Such systems are therefore built to allow for the continual updating of their databases.

9. Information systems are of great value in monitoring specific situations, observing an event or a situation and building a long-term series in order to detect possible changes, as well as to assist planning and prevention activities. The analytical capabilities of some of the systems (such as spatial decision support systems) to manipulate and transform interactively data that represent models of the real world and to build and explore different scenarios make them extremely valuable as major tools for both research work and application activities, as well as for decision-making.

B. Examples of information systems

10. In the above context, Earth observation from space provides a coherent, objective and regular source of input data for information systems. Data from meteorological and oceanographic satellites feed the meteorological models globally, on all scales. Images taken around the world from high-resolution satellites provide accurate and updated data to GIS, in particular for the monitoring of large territories.

11. As observation systems mature, efforts have been made in many countries by the space agencies and organizations concerned to develop national information and data-management systems addressing global issues. Those systems are extremely valuable multidisciplinary research tools available internationally for scientists, educators, researchers or the general public from all over the world. Some examples of such systems include the multimission user information services of the European Space Agency (ESA), where users can review on-line acquired satellite data, the Data Base of the World Meteorological Organization (WMO), the Information Locator System of the Committee on Earth Observation Satellites (CEOS) and the European Union's Centre for Earth Observation.

12. In India, the Indian Space Research Organization (ISRO) has initiated a national programme, establishing a Natural Resources Information System (NRIS), which is a three-tiered, hierarchically networked GIS database for natural resource management, sustainable development at the local level, monitoring the environment and supporting the decision-making process in different sectors. With integrated Earth observation data, map information and non-spatial developmental information inputs, the system is intended to provide a basis for developmental planning and decision-making. Similarly, the National Informatics Centre in India has set up a country-wide computer network that links all the districts in the country to state and regional centres and to the central hub. Tabular databases on developmental issues in every district are available through the network, thus making it an "intranet" for sustainable development activities.

13. In the United States of America, the National Aeronautics and Space Administration (NASA) has established the Earth Observing System Data and Information System (EOSDIS), which is a comprehensive data and information system developed under the Mission to Planet Earth programme (now the Earth System Science Programme). EOSDIS manages data from NASA's past and current Earth science research satellites and field measurement programmes, and provides data archive, distribution and information management services.

14. Another United States agency, the National Oceanic and Atmospheric Administration (NOAA), runs the Environmental Services Data Directory (ESDD), which allows users to search for publicly available environmental data held by public and private sources throughout the world. Data sources include descriptions related to climatology, meteorology, ecology, pollution, geology, oceanography and remote-sensing satellites.

The search pages of ESDD on the WorldWide Web connect separate databases that together contain over 8,000 data set descriptions. At present, ESDD consists of eight distributed databases, including the National Climatic Data Center, the National Oceanographic Data Center, the National Geophysical Data Center, the National Snow and Ice Data Center, the National Environmental Data Referral Service, historical data sets at NOAA libraries (the Library and Information Services Division and the Geophysical Fluid Dynamics Laboratory) and the National Marine Fisheries Service database.

15. In Japan, the National Space Development Agency (NASDA) and the Science and Technology Agency have initiated the Global Research Network System project at the Earth Observation Research Center. The purpose of the project is to conduct research on collecting satellite, ocean and ground observation data, developing data-processing algorithms and preparing global data sets for hydrology, vegetation, desertification and oceanology studies, as well as to promote international research projects focusing on global issues.

16. In France, Spot Image's Device to Access and Look at Spot Inventory (DALI) system contains meta-data for all the Système pour l'observation de la Terre (SPOT) satellite scenes that have been received by the Toulouse and Kiruna stations since the launch of SPOT 1 (in February 1986) and by most of the SPOT direct receiving stations all around the world. In addition, it holds quick looks, available for browsing purposes, of all the SPOT scenes received at the Toulouse and Kiruna stations since 1991. In 1995, some of the direct receiving stations started delivering quick looks to DALI, on top of meta-data. The connection to the system can be made through the Internet using the DALI WorldWide Web Access.

17. Space technology provides an essential contribution to improving the overall performance of information systems, not only by providing Earth observation data, but also by supporting the data flow worldwide through space communication systems, both in transferring input data and in delivering the output information.

18. The progress in technology has made advanced tools commercially available, both hardware and software packages, which respond to the current needs and requirements of the above-mentioned operations. The evolution of the market will make it possible to upgrade those tools as required.

II. INFORMATION NEEDS AND ISSUES

A. Overview

19. An important step in solving problems of global and regional significance is to identify the issues relevant to major problems and concerns such as those mentioned above in which space technology could contribute to the understanding and solution of those problems. A common issue for all such problems is the need to have a coordinated means to acquire necessary data in a timely manner for monitoring, analysing and modelling the environment of Earth.

20. International meetings of experts, including, for example, the International Symposium on Core Data Needs for Environmental Assessment and Sustainable Development Strategies, have led to the identification of 10 categories of data that are common input to many existing information systems addressing global issues. They are as follows: air quality; climatology; demographics; economy; hydrology; infrastructures; land use and land cover; soils; topography; and water quality. Many of the categories of data reflect "transboundary" processes and require regional or global cooperation to ensure that the appropriate data sets are produced.

21. For most of the research and application needs related to environmental issues, the sources of information are the same, namely, field observations, ground measurements, remote-sensing data taken by airborne and space-borne sensors, ancillary inputs from archives and databases and additional information from experience and from statistics. However, although many data products are being created by government, university and

other research groups, the products are often difficult to find, fragmented and poorly documented, or they are unavailable in a suitable medium or in an easily understandable form.

22. Four specific considerations should be taken into account when starting an application:

- (a) User requirements must be clearly defined from the very beginning;
- (b) Integration of data from the various sources that can support the information requirements of the application should be considered;
- (c) Use should be made of the experience gathered by others and, when possible, a regional joint endeavour should be sought;
- (d) Data purchase/access must be considered at the project definition stage.

When discussing the applications of information systems for the benefit of human developments, a key issue to be considered is continuity, with respect to both data and services. The timely availability of information and its continuity are a prerequisite to enabling a sound decision to be made. This is true not only in the case of the occurrence of a disaster, but also when a strategic plan has to be set up and approved. This means that the source of the data must provide them at the right moment and with the right frequency of repetition. The main problem of the Earth observation space systems currently operational is the low revisiting rate: the user has to wait several days or, more often, weeks before the satellite again passes over the same place with the same viewing geometry.

23. The future of space-based remote sensing for operational monitoring of the territory, environment and disasters is therefore moving towards constellations of satellites able to ensure the high revisiting rate needed by the applications that support sustainable development studies.

B. Important issues

24. Several other issues that should be taken into consideration, in particular in addressing the global problems that require at least regional cooperation, include cross-calibration of satellite sensors used over time and across different instruments to monitor the same geophysical parameter; ongoing international agreements to share near real-time data products to produce secondary products; and lack of, or the lack of knowledge on, *in situ* validation data in every corner of the world.

25. Another very important issue is the need for education and training. Without an adequate transfer of know-how from developed to developing countries and institutions it is almost impossible to conceive of sustainable development. All levels of training need to be considered and assured for technical specialists, data interpreters, students and professors, decision makers and project managers. Furthermore, on-the-job training and training follow-up activities are extremely necessary.

26. The translation of data into information for political decision makers to use is another crucial issue. The global problems mentioned above require decision-making at all levels of government. For example, land degradation problems can sometimes be handled locally by zoning boards, whereas decisions to combat ozone depletion and greenhouse gas emissions require international agreements and, perhaps, even legally binding commitments. Government leaders can make the commitments for their respective countries, but it is individuals working at the local and provincial levels who must understand the criticality of the situation and influence the leadership at those levels.

27. Therefore, in addition to collecting and preparing geophysical data for monitoring purposes and scientific analyses, the information must extend beyond the scientific community and be made available in a properly

interpretable form for individuals and decision makers at the local, state, province and country levels. However, to achieve the full potential of information systems for applications in decision-making processes, the required data sets should be built up in a systematic and integrated manner.

28. In this context, the availability of clear and up-to-date information on technical issues and application results is essential to derive the full benefit from the use of information systems addressing global problems. Worldwide exchanges of information and the regular participation of researchers and decision makers in thematic workshops and conferences are also extremely important, together with appropriate access to the international computer and electronic mail (e-mail) networks and the Internet, and the link to global information infrastructures.

29. Another important issue concerns the protection of intellectual property rights. As various new information systems have been developed, this issue has become one of the most debated problems, as reflected in the discussions on international actions to ensure world protection of intellectual property rights for databases. Various legislative initiatives have been proposed in that regard. The European Communities have adopted a directive on databases that could greatly increase the protection of intellectual property rights of database creators and vendors in both the private and the public sectors. Similar legislative initiatives were introduced in both the United States Congress and the World Intellectual Property Organization. Although neither of the proposals was adopted, the legal changes that have been enacted in Europe and that are still being vigorously promoted in the United States and elsewhere have a number of attributes that could severely restrict data exchange, access and use by researchers, educators and other public interest users.

III. ECONOMIC AND SOCIAL BENEFITS*

30. The main economic and social benefits deriving from the use of information systems supported by space technology can be summarized as follows (not necessarily in order of priority):

- (a) Increased understanding among policy makers, researchers and the general public of the interactions between different environmental issues, as well as between the environment and development;
- (b) More accurate and integrated assessment of the overall environmental situation, permitting more pertinent decisions to be made and minimizing the waste of resources and the duplication of effort;
- (c) Availability of detailed information over large areas, permitting implementation of global actions;
- (d) Transfer of know-how, expertise and knowledge from industrialized to developing countries, as well as development of educational and training capabilities at the local level;
- (e) Increased regional and international cooperation through joint projects and data sharing;
- (f) Development of new technologies, resulting from scientific research on preventing, mitigating or adapting to the effects of global changes, which are useful for:
 - (i) Reducing energy consumption through conservation and energy efficiency;
 - (ii) Promoting the use of solar and renewable energy sources that reduce the amount of greenhouse gases released into the atmosphere;

*A detailed review of economic and social benefits is given in background paper 11, "Economic and societal benefits" (A/CONF.184/BP/11).

- (iii) Developing replacements for chlorofluorocarbons and other ozone-depleting substances that exhibit a significantly reduced potential for depleting stratospheric ozone;
- (iv) Promoting the conservation of forest resources that help to reduce the amount of carbon dioxide in the atmosphere;
- (v) Assisting developing countries in ecological pest management practices and in the proper use of agricultural and industrial chemicals;
- (vi) Promoting recycling of pollutants in order to reduce the volume of waste that must be disposed of, thus decreasing energy use and greenhouse gas emissions;

(g) Development of reliable telecommunications infrastructures, which are essential for accurate and timely communications among data centres to transfer remote-sensing and other inputs needed by information systems and to disseminate the information generated by those systems.

IV. PROMOTION OF INTERNATIONAL COOPERATION*

A. Prerequisites

31. Satellite systems may act as bridges between countries at different levels of development, those levels not necessarily being related to the degree of industrialization of the countries involved.

32. In general, international cooperation encourages the initiation and domestic support of a project and provides a complement to national technical or material resources. However, three basic prerequisites need to exist at the national level for the successful implementation of a project and related developments, the local institutional commitment, the national investment and the local availability of skilled people and proper infrastructure, to ensure a proper transfer of know-how and technology, in particular in the domain of information systems.

33. The areas in which cooperation proves most effective include education (both in the form of stimulation of interest for decision makers and of specific training for technical specialists, students and teachers), technical assistance (in ground infrastructure, data processing, application work, planning, purchasing, operating and maintaining facilities), legal assistance (access fees, copyright and intellectual property rights), provision of hardware and software tools, data (provision of basic data sets to start working with or to demonstrate the feasibility of an application), meetings (creating venue opportunities in order to favour cross-fertilization between developing countries and industrialized countries) and provision of information (through contacts, documentation, e-mail conferencing and computer networks links).

34. Opportunities occur most frequently through application projects, either by joining existing projects or by creating new ones, in both cases looking for regional or international partnerships, which facilitate sponsorship by national and/or international institutions.

B. International programmes

35. A number of international initiatives are being carried out to address global environmental issues, including such programmes as the International Geosphere-Biosphere Programme, the Mission to Planet Earth

*A detailed review of international cooperation is given in background paper 12, "Promotion of international cooperation" (A/CONF.184 BP/12).

programme, and the World Climate Research Programme, which is a part of the World Climate Programme, and the International Human Dimensions Programme of Global Environmental Change.

36. Three global observing systems, comprising both ground- and space-based observations data, have also been established: the Global Climate Observing System, established by the United Nations Environment Programme (UNEP); the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO), WMO and the International Council of Scientific Unions (ICSU); the Global Ocean Observing System, being developed by UNEP, IOC/UNESCO, WMO and ICSU; and the Global Terrestrial Observing System, set up by UNEP, the Food and Agriculture Organization of the United Nations, UNESCO, WMO and ICSU.

37. In the area of international cooperation in data access and management, several information systems have been developed by various international projects and programmes in order to provide the global scientific community with on-line access to data. One of the most successful activities in the field has revolved around CEOS. At present 11 countries host mirror information sites that offer over 5,000 data set descriptions from around the world, including from developing nations, through the CEOS International Directory Network. Two of the host sites are associated with UNEP (in Geneva and Nairobi).

38. The CEOS International Directory Network has been developed as an international effort to assist researchers in locating information on available data sets. The Network is sponsored by the Access Subgroup of the Committee on Earth Observation Satellites as a service to both the Earth and space science communities. It provides open on-line access to information on worldwide scientific data, including Earth sciences (geosciences, satellite remote sensing and hydrospheric, biospheric and atmospheric sciences), space physics, solar physics, planetary science and astronomy and astrophysics. The Network describes data held by university departments, government agencies and other organizations.

39. The International Geosphere-Biosphere Programme Data and Information System is a system devoted to understanding the data needs of the core projects of the Programme and to helping to ensure that those needs can be met. This involves such tasks as liaison with data holders internationally, providing documents where gaps exist and providing information on available and useful data standards from relevant organizations.

C. The Global Resource Information Database of the United Nations Environment Programme

40. The UNEP Global Resource Information Database (GRID) is a worldwide network of environmental data centres that was established to provide the global community with timely and reliable geo-referenced information and access to a unique international GIS service, with a view to addressing environmental issues at the global, regional and national levels in order to bridge the gap between scientific understanding of Earth processes and sound management of the environment.

41. The long-term objectives of GRID are as follows: (a) to enhance the availability and open exchange of global, regional and national geo-referenced environmental data sets, in digital and other formats; (b) to provide United Nations and other governmental bodies with access to improved environmental information and data-management technologies; and (c) to enable all countries and regions of the world to make use of GRID-compatible technology for resource management, environmental assessment, state-of-environment reporting and informed decision-making.

42. GRID works in a cooperative manner through 13 centres worldwide, each with its own responsibility in respect to both geographical data coverage and projects/services offered to users. Thus, for example, within the GRID network, the GRID-Geneva node has specific responsibility for the acquisition, documentation, archiving and dissemination of global and European digital, geo-referenced environmental data sets. It also specializes in data preparation and value-adding, database development, data search and provision through the Internet and WorldWide Web, hardware/software expertise and networking with partner agencies in general.

43. Another node, the GRID-Sioux Falls centre in the United States was set up to help nations attain sustainable development by making remotely sensed images and other spatial information available, as well as to develop methods for using that information to support models of population and the environment. GRID-Sioux Falls provides access to the extensive data archive of satellite imagery housed at the Earth Resources Observation System (EROS) Data Center of the United States Geological Survey. The primary database development activities are land cover characteristics, digital elevation mapping and the analysis of environmental change.

44. In addition, GRID-Sioux Falls, in cooperation with the EROS Data Center, is developing a geospatial data clearing house capability for the UNEP Caribbean Regional Coordinating Unit (CAR/RCU) office in Kingston as a part of the Environmental Information System project of the Caribbean Environment Programme, funded jointly by the United Nations and the Inter-American Development Bank. The goal of the project is to strengthen the information systems for the management of marine and coastal resources in the Caribbean region. This is being pursued through the development of information systems as tools for use in natural resource management and by the inter- and intra-regional exchange of expertise on natural resource management. Regional clearing house nodes will initially be established in designated environmental agencies in six countries: Barbados, Dominican Republic, Jamaica, Nicaragua, Trinidad and Tobago and Venezuela. Eventually, expansion is expected to include all 35 nations of the wider Caribbean region.

D. Other projects

45. The Inter-American Geospatial Data Network has been established to promote the use of computer network, primarily the Internet, capabilities in the Western hemisphere for electronic access to information describing the existence and availability of geospatial data. It is a project of the United States Agency for International Development, in partnership with the United States Geological Survey, designed to enhance information infrastructures as requested by the Summit of the Americas in December 1994. The initial collaborators have important collections of geospatial data for sites throughout the Americas, and are located in the United States, Brazil and Central America.

46. The global observation information network has been implemented as a cooperative effort between the United States and Japan to strengthen cooperation in Earth observation information networks, involving both satellite and *in situ* data. Other cooperative efforts in information systems development, data access and management include the Earth Observing System—Data and Information System project, the Global Land Information System and the CEOS Information Locator System.

47. Adequate and effective access to the data is a prerequisite for the successful use of information systems and this is impossible without modern methods of telecommunication. In order to facilitate the global exchange of environmental information vital for an understanding of urgent local and global environmental problems and information systems, a number of ESA member States have jointly supported the development of a satellite communications system for UNEP.

48. The Mercure system comprises 16 Earth stations serving two sub-networks. It provides UNEP with modern global telecommunications capabilities for the fast transfer of large volumes of environmental data, such as those representing detailed images of the Earth acquired from environmental satellites, and real-time video teleconferences between UNEP centres, as well as for handling Internet-type data traffic. The Mercure system has also been integrated into the UNEP global environment information network, UNEPnet.

49. The initial Mercure system is only the core of a much larger network. Several UNEP member States have indicated that they intend to acquire Mercure stations, while Norway is already providing facilities in Arendal, south of Oslo, for the administration of UNEPnet, including Mercure, and has provided the resources for the installation of a ground station there.

V. SOME SELECTED ISSUES OF INTEREST TO MEMBER STATES, IN PARTICULAR DEVELOPING COUNTRIES

50. Information systems are extremely powerful and effective tools for research and applications addressing global environmental issues. The use of those systems also makes an important contribution to sustainable development programmes in a number of ways, including: (a) allowing the implementation of an improved policy- and decision-making process based on timely and accurate data provided through modern technology; (b) building and strengthening institutional capabilities and developing human resources; and (c) making available a set of planning tools and techniques for improved natural resource management, environmental monitoring, sustainable development and disaster reduction, preparedness and management.

51. The target beneficiaries of activities associated with the use of information systems are the participating Governments and the relevant national/regional institutions; the decision makers and programme managers and operators; the technical, managerial and administrative personnel involved in the identification and the implementation of programme and project activities; the communities directly affected; individuals and end-users of programme- and project-related activities; and private companies.

52. However, to achieve the full potential of information systems for applications in support of sustainable development, a number of key issues should be considered. These include:

- (a) Clear definition of user needs and requirements;
- (b) Appropriate access to data and services;
- (c) Inventory of all available data and information pertaining to the environment;
- (d) Continuity of data and services;
- (e) Development of standard meta-data formats for information exchange;
- (f) Identification of *in situ* data available;
- (g) Availability of capabilities in developing countries to establish information systems;
- (h) Necessity to build required data sets in a systematic and integrated manner;
- (i) Adequate access to telecommunications and computer networks ensuring the ability to reach remote data centres and information systems;
- (j) Integration of national information systems into national information infrastructures and eventually into the global information infrastructure;
- (k) Appropriate education, training and transfer of know-how;
- (l) The impact of the protection of intellectual property rights, security measures and restricted access to databases on international information exchange;
- (m) Frameworks for regional and international cooperation.

53. Another issue that may require the attention of developing countries is the support of national commercial information services and value-added companies operating in the area of remote-sensing data products and

services, thematic information for specific applications and the development of, or supplying data for, information systems, especially GIS. The growth of such companies in number and experience is certainly an asset for the sustainable development of a country.

54. Business opportunities exist in the various areas related to the design, development, integration, validation and operations (data distribution and applications and generation of thematic information) of remote-sensing and information systems. Companies can also look for continuous and recurring business to capitalize on investments (systematic provision of data, information, services and support). In particular, value-added companies could seek opportunities for joint ventures, participating in international projects to develop their expertise and to become known.